

ME-6232

INSTRUCTION MANUAL

6232
EMR MODEL 4820
GENERAL-PURPOSE AMPLIFIER
(REVISION B)



TELEMETRY

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual contains information describing the EMR Model 4820 General-Purpose Amplifier. Included in this information is a functional and physical description, specifications, installation and operation, theory of operation, maintenance, and replaceable parts list.

The Model 4820 is a modular unit designed for mounting in an EMR Model 4005 Rack Adapter. Two standard units are available in the Model 4820 series, a Model 4820-01 and Model 4820-02. These units are identical except for the output configuration. Specific differences between these units are noted in the appropriate locations of this manual.

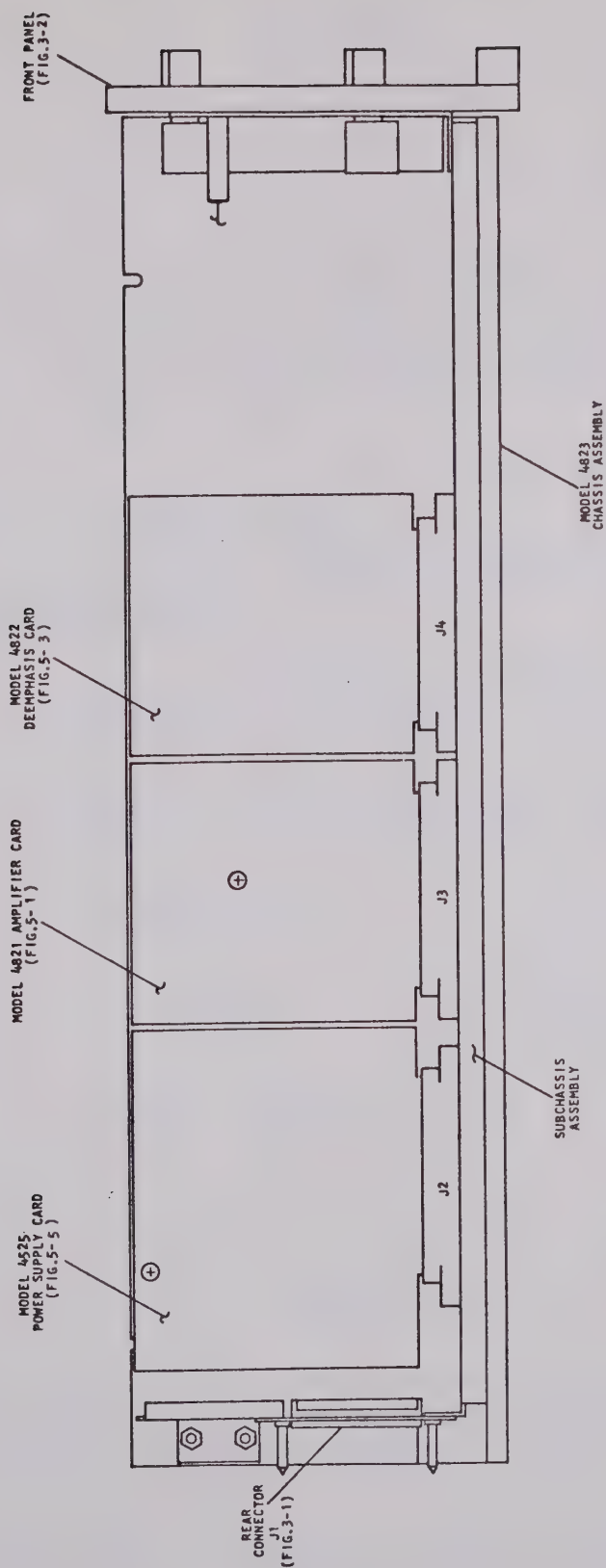
1.2 FUNCTIONAL DESCRIPTION

The Model 4820 is designed for use as a ground-based wide-band mixing amplifier, isolation amplifier, or line-driving amplifier. Major circuits of the Model 4820 include an operational amplifier, a deemphasis network, and a power supply and regulator. Inputs to the amplifier consist of a fixed input and an adjustable input. Signals applied to these inputs are algebraically summed, amplified, and supplied on a single-ended output (Model 4820-01) or a floating output (Model 4820-02). Gain parameters for the amplifier may be set to 0.5, 1, 2, or 5 by a front panel control.

A deemphasis network is provided for the adjustable input to the amplifier. This network operates as a low-pass filter with selectable cutoff frequencies. Any of six (five standard and one special) cutoff frequencies are selected by a front panel control. The power supply and regulator operates from a primary AC power input of 108 to 132 volts to generate the DC voltages for operation of the Model 4820.

1.3 PHYSICAL DESCRIPTION

The Model 4820 is a one modular width unit designed for installation in an EMR Model 4005 Rack Adapter. The rack adapter is intended for mounting in a standard 19-inch equipment rack or portable instrument case. Panel height required to mount the rack adapter is 5-1/4 inches. The rack adapter is capable of housing up to 14-modular increments of equipment, each 1-7/32 inches wide. The Model 4820 and all major subassemblies are illustrated and identified in the assembly diagram, Figure 1-1.



NOTE:
1. ENR DWG. CONT. NO. 4820-001

Figure 1-1. Model 4820 Assembly Diagram

SECTION 2

SPECIFICATIONS

2.1 GENERAL

This section contains the electrical, mechanical, and environmental specifications for the Model 4820 General-Purpose Amplifier. These specifications are outlined in paragraphs 2.2, 2.3, and 2.4. Also included in this section is information (Table 2-1) to aid in identifying the unit parameters by a model number stamped on the nameplate.

2.2 ELECTRICAL SPECIFICATIONS

- a. Frequency Response: The following specifications apply with full load and full output.

1. Model 4820-01--Within 3 Db from 300 Hz to 2 MHz, except at a gain setting of 5. Frequency response for a gain setting of 5 is within 3 Db from 300 Hz to 1 MHz.
2. Model 4820-02--Bandwidth specified on particular unit. The frequency response for standard units is as follows:

<u>Cutoff Frequency</u>	<u>3-Db Bandwidth</u>
250 KHz	300 Hz to 250 KHz
1 MHz	30 KHz to 1 MHz
*2 MHz	100 KHz to 2 MHz

*For gain settings less than 5

- b. Input Impedance:

1. Input 1--2000 ohms minimum (adjustable input).
2. Input 2--10,000 ohms $\pm 10\%$ (fixed input).

- c. Gain: Gains of 0.5, 1, 2, or 5 are selectable by front-panel switch. For input 1, adjustable input, gain is variable from zero to the selected position by front-panel vernier control. For input 2, fixed input, gain is fixed at selected value $\pm 10\%$.

- d. Output Level: 20 volts peak-to-peak maximum in no-load condition; 10 volts peak-to-peak maximum with a 50-ohm load.

- e. Output Impedance: 50 ohms $\pm 20\%$. The output resistor is mounted to terminals so that a higher-value resistance may be installed. The Model 4820-02 output (floating) must be terminated with a resistance equal to the output resistor.
- f. Harmonic Distortion: Less than 1% of the fundamental output at unity gain, and with full output/full load.
- g. Intermodulation Distortion: When two sine waves of equal amplitude and different frequencies are mixed, the amplitudes of the sum and difference frequencies are less than 1% of the amplitude of the applied inputs.
- h. Deemphasis: 6 Db/octave rolloff for the six cutoff frequencies selected at front panel switch. Five cutoff frequencies (300 Hz, 1 KHz, 3 KHz, 10 KHz, and 30 KHz) are standard. The sixth is adjusted per operating requirement. Terminals are supplied for installation of cornering capacitor. For information to select capacitor value, refer to Section 3.
- i. Noise: Less than 1 millivolt RMS when inputs are grounded.
- j. Power Requirements: 108 and 132 volts RMS, 47 to 420 Hz, single phase; 207 to 253 volts RMS, 47 to 63 Hz. Maximum power dissipated is 10 watts at 120-volt RMS input.

2.3 MECHANICAL SPECIFICATIONS

- a. Panel Size: 5-1/4 inches (13.3 Cm) high by one modular width (1.22 inches; 3.09 Cm).
- b. Depth: 16-3/4 inches (42.5 Cm) excluding projections from front panel.
- c. Net Weight: 3-1/8 pounds (1.42 Kg).
- d. Shipping Weight: 5 pounds (2.27 Kg).

2.4 ENVIRONMENTAL SPECIFICATIONS

- a. Operating Temperature Range: $+10^{\circ}\text{C}$ to $+50^{\circ}\text{C}$ circulating air.
- b. Storage Temperature Range: -55°C to $+85^{\circ}\text{C}$.

Table 2-1. EMR Model 4820, Model Number Identification

EMR MODEL 4820 - XX - XXXX.XXX - XX - GENERAL-PURPOSE AMPLIFIER			
This digit identifies the power options as follows: 0--105 to 132V RMS, 47 to 440 Hz. 8--207 to 253V RMS, 47 to 63 Hz.	This digit identifies the design sequences as follows: 1--Non-floating output. 2--Floating output.	These digits identify the amplifier cutoff frequency. As shown above, the amplifier cutoff frequency should be specified in seven-digit KHz. 2000.000 KHz is standard for design sequence 01. 0250.000 KHz, 1000.000 KHz, and 2000.000 KHz are standard for design sequence 02.	These digits identify panel paint and lettering codes (W and B following color codes refer to White or Black lettering). 01--Light Green 00048W 02--Dark Green 00049W 04--Gray 26492B 99--Special Paint

SECTION 3

INSTALLATION AND OPERATION

3.1 INSTALLATION

The Model 4820 General-Purpose Amplifier is shipped completely assembled and ready for mounting. Any shortage or damage to the unit should be reported in accordance with the instructions contained in the EMR Purchase Order Acknowledgement (POA).

The Model 4820 is a modular unit designed for mounting in an EMR Model 4005 Rack Adapter. The modular unit is positioned on T-rails in the rack adapter bottom surface and is inserted into the mounting location. A push-to-lock knob on the front panel secures the unit in the assigned location of the rack adapter. The rear connector, J1, mates with a receptacle in the rack adapter interior to complete the electrical connections.

The position of the Model 4820 in the rack adapter and the internal wiring of the rack adapter is contained in the Model 4005 Rack Adapter Instruction Manual. Electrical connections terminated at the rear connector, J1, are illustrated in Figure 3-1.

Internal cooling for the Model 4820 is provided by a blower mounted on the rear panel of the rack adapter.

3.2 OPERATION

3.2.1 Front-Panel Controls and Monitor Jacks

The front-panel controls and monitor jacks used for operation of the Model 4820 are illustrated in Figure 3-2 and described in Table 3-1.

3.2.2 Deemphasis Component Selection

Five standard cutoff frequencies and one special cutoff frequency adjustment is provided in the deemphasis network of the Model 4820. The cutoff frequencies are selected by front-panel DEEMPHASIS CUTOFF switch S2. This switch selects any of five capacitors installed on the deemphasis card to provide the desired response. The sixth position selects an operator installed capacitor sized to provide a cutoff frequency not supplied with the unit. To select the value of capacitance necessary for other cutoff frequencies, proceed as follows:

- a. Select the desired cutoff frequency per the particular requirement.
- b. The capacitive reactance (X_c) at the selected frequency should equal 2.5K ohms.
- c. Using the following formula, calculate the necessary capacitance:

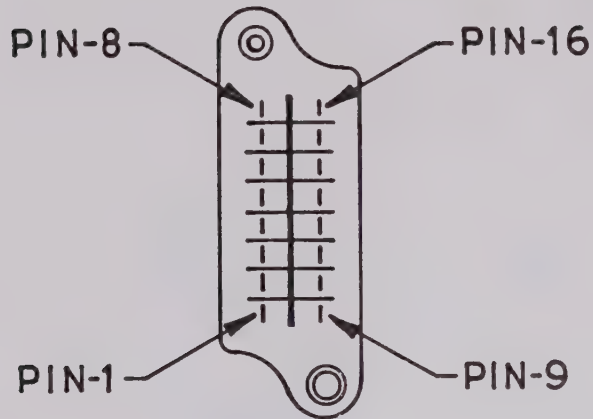
$$C = \frac{1}{2\pi F(2500)} \text{ fd}$$

- d. Select the closest value capacitor and install this component between terminals E1 and E2 of deemphasis card.

Table 3-1. Model 4820, Function of Front Panel Controls and Monitor Jacks

DESIG	NAME	FUNCTION
S1	AMP GAIN Switch	Provides amplifier gain settings of 0.5, 1, 2, and 5.
R1	VERNIER Control	Adjusts the amplitude of the signal applied to the adjustable input, INPUT 1
S2	DEEMPHASIS CUT-OFF KHz Switch	Selects the cutoff frequency of the deemphasis network for INPUT 1 to the amplifier. Cutoff frequencies of 300 Hz, 1 KHz, 3 KHz, 10 KHz, and 30 KHz are standard. A sixth position is used when deemphasis is not required or when a special cutoff frequency is desired.
TP1	OUT Test Jack	Signal output.
TP2	GRD Test Jack	Signal ground.

Connector Layout



External Connections

PIN	FUNCTION
1	INPUT #1. VARIABLE
2	SIGNAL GROUND
3	
4	
5	
6	
7	AC NEUTRAL
8	AC PHASE
9	INPUT #2
10	SIGNAL GROUND
11	
12	
13	
14	OUTPUT
15	OUTPUT RETURN
16	CHASSIS GROUND

Unit Model No. 4820-01, -02, -71,
-72, -81 and -82

Figure 3-1. Model 4820 External Electrical Connections

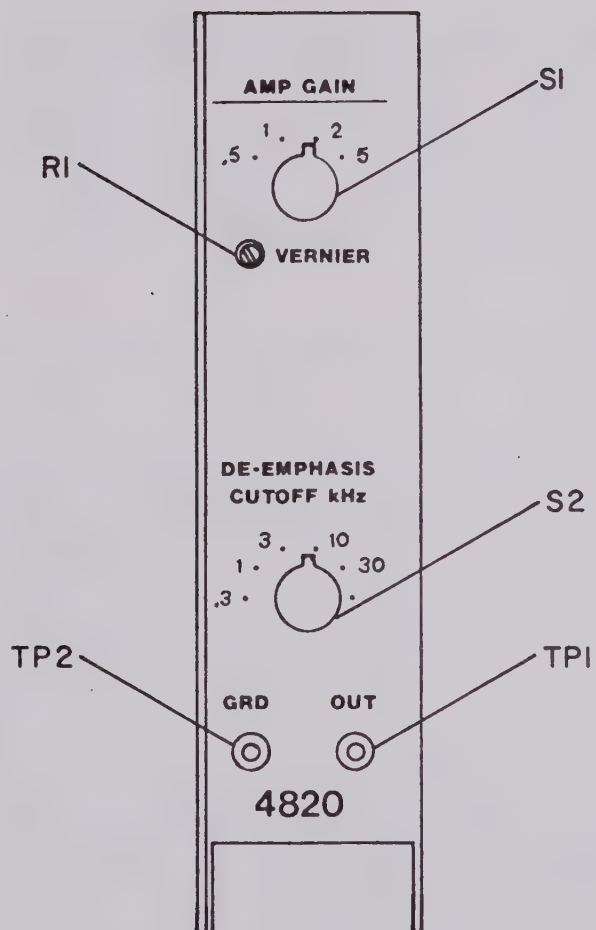


Figure 3-2. Model 4820 Front Panel Controls

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

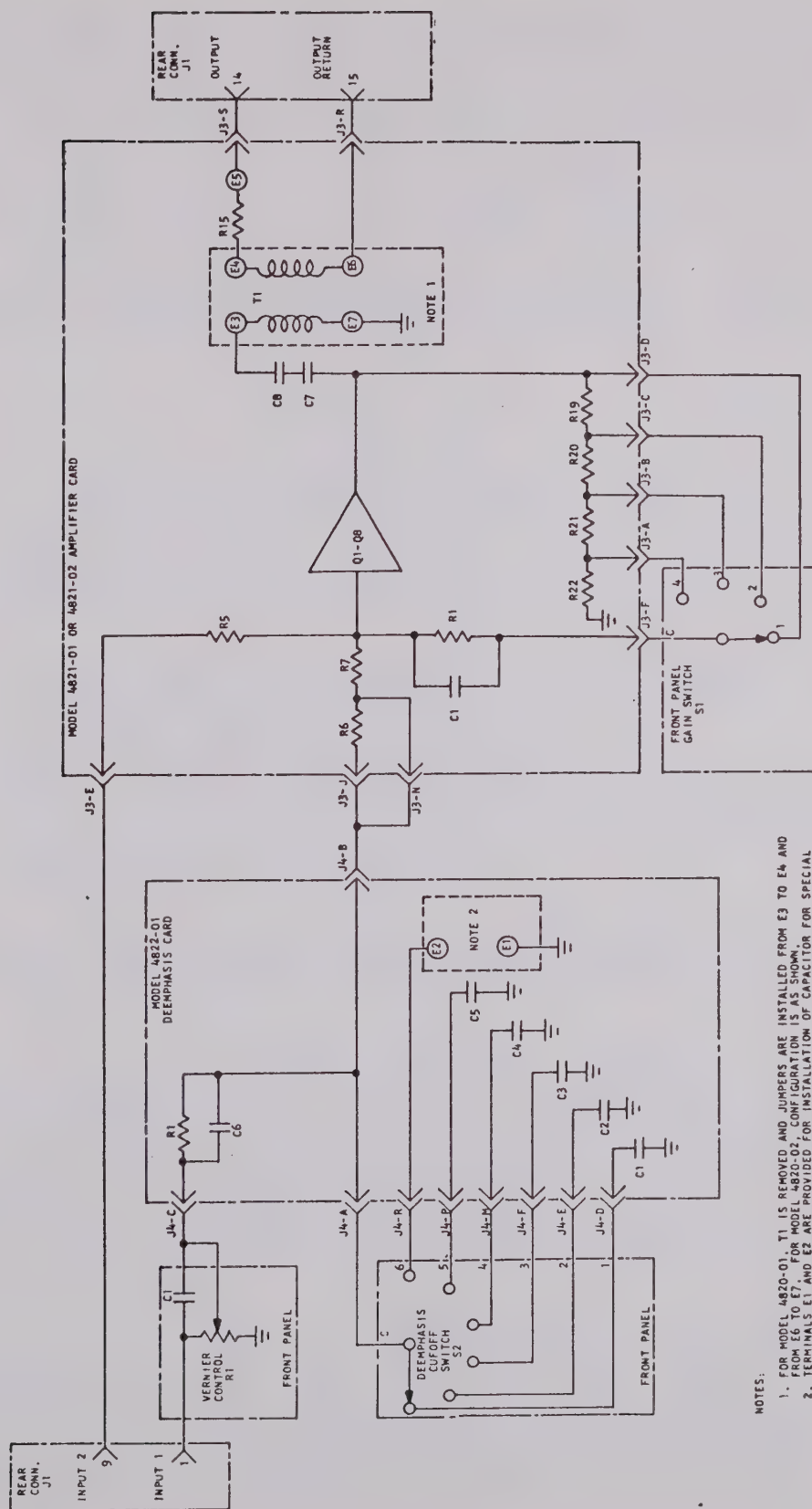
This sections contains the detailed theory of operation for the Model 4820 General-Purpose Amplifier. Included in the theory discussion is a description of the amplifier and deemphasis circuits, and power supply and regulator circuits. These circuit descriptions are contained in paragraphs 4.2 and 4.3 with reference to the simplified schematic diagram, Figure 4-1, and detailed schematic diagrams contained in Section 5. For a general description of the Model 4820, refer to the functional description contained in Section 1, paragraph 1.2.

4.2 AMPLIFIER AND DEEMPHASIS CIRCUITS (REF. FIGURE 4-1)

The amplifier circuit is a conventional operational amplifier containing provision for two input signals, a fixed input, and an adjustable input. Amplifier output configurations vary depending on the particular unit. For the Model 4820-01, the output configuration is single-ended and referenced to signal ground. The Model 4820-02 contains an output transformer providing a floating output. An adjustable feedback network controlled by a front panel switch provides four amplifier gain settings, 0.5, 1, 2, and 5. Components of the amplifier circuit are contained on the Model 4821 amplifier card mating with chassis receptacle J3.

Inputs to the amplifier include an adjustable input (INPUT 1) and a fixed input (INPUT 2) derived from rear connector J1 pins 1 and 9. The signal applied to INPUT 1 is coupled through front panel VERNIER control R1 and a series resistor on the deemphasis card to pins J and N of the amplifier card mating connector J3. INPUT 2 is coupled directly to pin E of the amplifier and mating connector J3. Signals on these inputs are algebraically summed by resistors R5/R7 and are amplified by the amplifier circuit consisting of transistors Q1-Q8. The amount of amplification is determined by the gain setting at front panel GAIN switch S1. This switch selects the amount of feedback voltage at resistors R19-R22 required to obtain the gain parameters.

The amplifier output is AC coupled through capacitors C7/C8 to the primary winding of T1 (Model 4820-02 only). The secondary of T1 with series resistor, R15 (43-ohms), supplies a floating output at pins 14 and 15 of rear connector J1. For the Model 4820-01, the output is coupled through C7/C8 and R15 to pin 14 of rear connector J1. This output is single-ended and referenced to the output ground, pin 15 of rear connector.



- NOTES:
1. FOR MODEL 4820-01, T1 IS REMOVED AND JUMPERS ARE INSTALLED FROM E3 TO E4 AND FROM E6 TO E7. FOR MODEL 4820-02, CONFIGURATION IS AS SHOWN.
 2. TERMINALS E1 AND E2 ARE PROVIDED FOR INSTALLATION OF CAPACITOR FOR SPECIAL CUTOFF FREQUENCY.
 3. ERR. DWG. CONT. NO. 4820-002.

Figure 4-1. Model 4820 Simplified Schematic Diagram

The deemphasis network, contained on the deemphasis card, is a low-pass filter connected in the fixed input (INPUT 1) to the amplifier. This network consists of a fixed resistor, R1, and selectable capacitor combinations, C1-C5, providing a rolloff of 6 Db/octave beyond the selected cutoff frequency. Cutoff frequencies of 300 Hz, 1 KHz, 3 KHz, 10 KHz, and 30 KHz are selectable by front-panel DEEMPHASIS switch, S2. A sixth position at S1 is supplied for use in conjunction with a special cutoff frequency determined by a capacitor installed between terminals E1 and E2. These terminals are left open, enabling the operator to select the proper value capacitor for the desired cutoff frequency. Information regarding the capacitor value selection/cutoff frequency is provided in Section 3 of this manual.

4.3 POWER SUPPLY AND REGULATOR CIRCUIT (REF. FIGURE 5-6)

The power supply circuits operate from a primary power input of 108 to 132 volts (Models 4820-01 and -02) or 207 to 253 volts (Model 4820-81) to generate all voltages for operation of the Model 4820. Components of these circuits are contained on the power supply card mating with chassis receptacle J2.

The power supply circuits, shown in Figure 5-6, include a step-down transformer, a diode rectifier assembly, in-line fuses, and regulator circuits. The primary power input is applied from rear connector J1, pins 7 and 8, through pins B and C of the power supply card connector P1 to the primary winding of transformer T1. The secondary winding of T1 is connected to a dual full-wave diode rectifier assembly CR3 which rectifies the AC input providing unregulated DC voltages to the regulator circuits. In-line fuses, F1 and F2, provide over-current protection in the rectifier output.

The regulator circuits consist of a plus (+) regulator and a minus (-) regulator. The plus and minus regulator output voltages are adjustable between 16.0 volts and 18.5 volts by potentiometer R6 connected across the minus regulator output.

Regulation in the minus regulator, transistors Q1 through Q4 and Q8, is accomplished by comparing a sample of the output voltage with a voltage reference established by zener diode CR4. A differential comparison amplifier, Q3/Q4, senses the magnitude and direction of any voltage difference and generates an out-of-phase signal controlling the biasing of the Darlington-connected series regulator Q2 and Q8. Constant-current generator Q1 and diodes CR1/CR2 supplies quiescent current for transistor Q4 in the differential comparison amplifier.

Regulation in the plus regulator, transistors Q5 through Q7 and Q9, is accomplished in a similar manner except that output voltage fluctuations are detected by transistor Q7. Transistor Q7 senses the magnitude and direction of output voltage fluctuations and generates an out-of-phase signal controlling the biasing of a second Darlington-connected series regulator, Q6 and Q9.

SECTION 5

MAINTENANCE

5.1 GENERAL

This section contains information to aid in troubleshooting and maintaining the Model 4820 General-Purpose Amplifier. This information is intended to be used in conjunction with the theory of operation, contained in Section 4, so that maintenance may be performed with maximum efficiency. Included in the maintenance information are troubleshooting guides (paragraph 5.2), test and adjustment procedures (paragraph 5.3), and assembly and schematic diagrams for the unit assemblies (Figures 5-1 through 5-7).

5.2 TROUBLESHOOTING

In the event an abnormal condition is detected in unit operation, the following general method of isolating and repairing the trouble is recommended:

- a. Perform visual inspection (paragraph 5.2.1).
- b. Perform maintenance procedures (paragraph 5.2.2).
- c. When defective component is located, refer to Section 6, Parts Lists, for replacement component description.
- d. Perform test and adjustment procedure to ascertain malfunction is corrected.

5.2.1 Visual Inspection

The Model 4820 should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. The following inspection should be performed periodically as a means of preventive maintenance or, if a malfunction occurs, to aid in isolating the trouble.

- a. Inspect front-panel components and rear connector for signs of damage.
- b. Inspect wiring for loose or broken connections.
- c. Inspect printed-circuit cards for mechanical damage or component discoloration.

- d. Inspect printed-circuit card connectors and mating chassis receptacles for signs of damage.

5.2.2 Maintenance Procedures

Procedures for isolating malfunctioning components are as follows:

- a. Check power supply DC voltage outputs at pins A and L of the power supply card connector P1. Voltages should be as follows:

Pin A-- -16.5 volts $\pm 1\%$.

Pin L-- +16.5 volts $\pm 5\%$.

If DC voltage outputs are not present, troubleshoot power supply card using typical voltages supplied on the schematic diagram, Figure 5-6. To locate specific components on the power supply card, refer to component location diagram, Figure 5-5.

- b. Check the amplifier circuit as follows:
 1. Since the amplifier is a closed-loop circuit, a malfunctioning stage is difficult to locate using a dynamic test procedure. However, a majority of amplifier malfunctions will be repaired by transistor replacement. To locate an inoperative stage, check DC voltages at transistor elements or measure resistances between transistor elements (see Figures 5-1 and 5-2).
 2. A malfunction is chassis components or wiring is located by resistance and continuity measurements (see Figure 5-7).

5.3 TEST AND ADJUSTMENT PROCEDURE

The test and adjustment procedure is divided into a power supply test and adjustment and an amplifier test. Procedures for these tests and adjustments are contained in the following paragraphs.

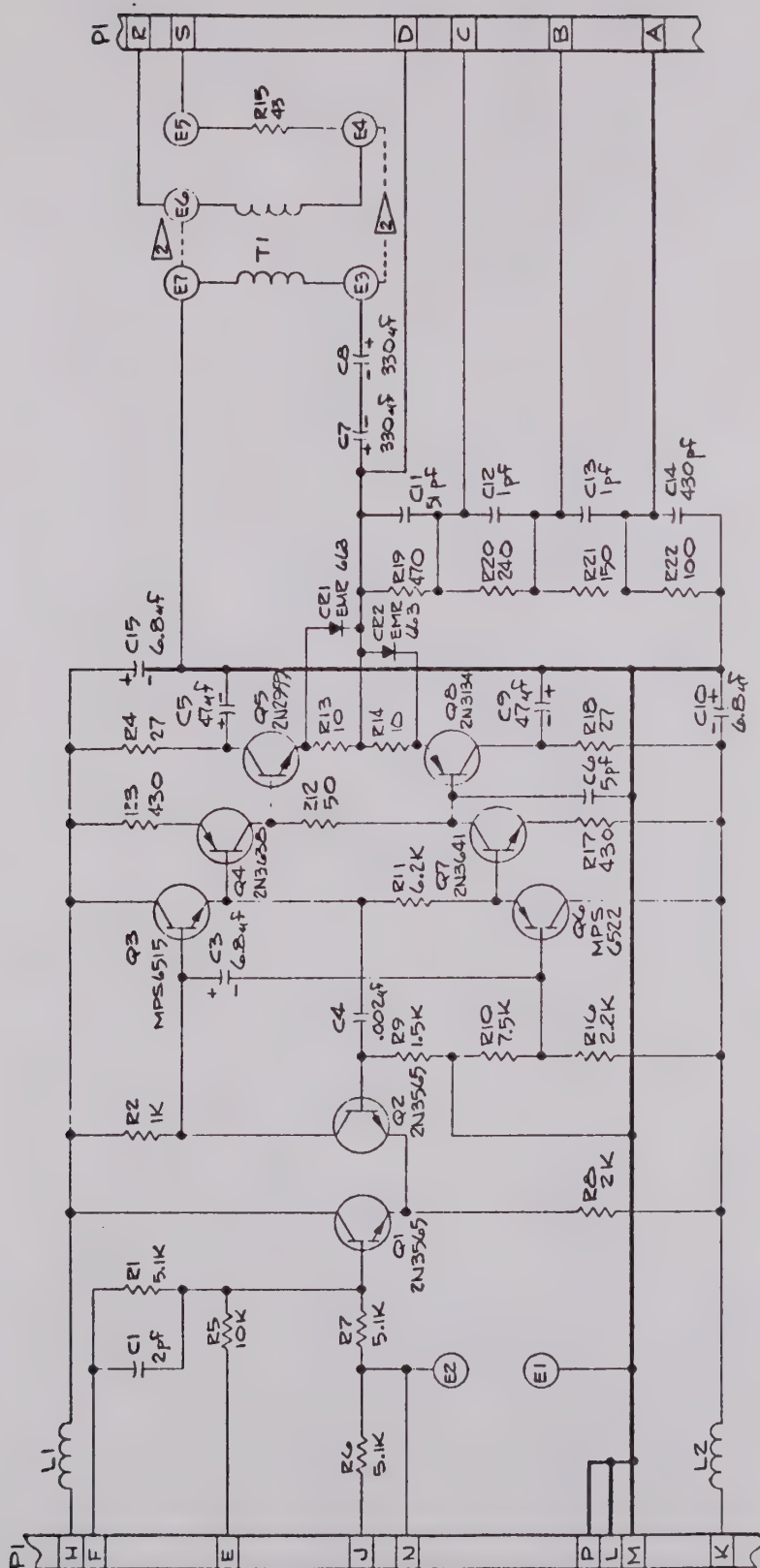
5.3.1 Power Supply Test and Adjustment (See Figures 5-5 and 5-6)

- a. Apply primary AC power to the unit.

- b. Using a DC voltmeter, monitor pin A of the power supply card connector, P1.
- c. On the power supply card, adjust potentiometer R6 for a -16.5-volt $\pm 1\%$ indication.
- d. Check the voltage at power supply card connector pin L for a +16.5-volt $\pm 5\%$ indication.

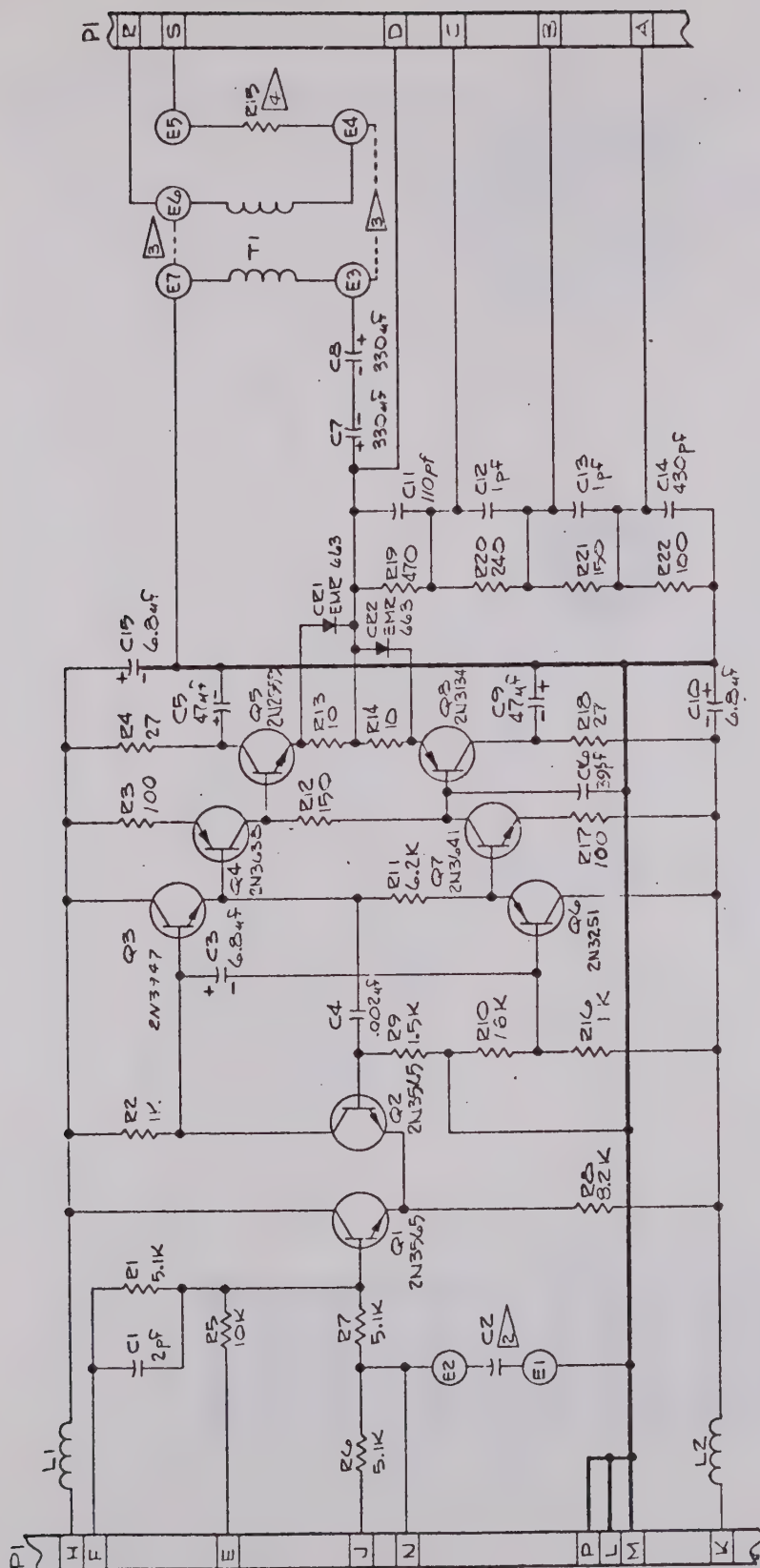
5.3.2 Amplifier Test (See Figures 5-1 and 5-2)

- a. Apply 0-volt signals to both amplifier inputs and operate the amplifier in an unloaded output condition.
- b. Using an oscilloscope, check the DC level at amplifier card connector P1, pin D. This voltage should be 0 volt ± 0.5 volt.
- c. Position the front-panel GAIN switch to .5.
- d. Remove the ground-level signal at INPUT 2 of the amplifier and apply a 2-volt peak-to-peak signal at INPUT 2. The frequency of this signal input is adjusted to any value within the amplifier specifications.
- e. Using an oscilloscope, check the amplifier output for a 1-volt $\pm 10\%$ peak-to-peak indication.
- f. Check the remaining positions of the GAIN switch in a similar manner to ascertain that the amplifier gain is within $\pm 10\%$ of the indicated gain setting.
- g. Connect a 50-ohm load across the amplifier output terminals.
- h. Using an oscilloscope, monitor the amplifier output and increase the amplitude of the input signal until the amplifier output increases to an undistorted 10-volt peak-to-peak signal.



NOTES:
 1. UNLESS OTHERWISE SPECIFIED:
 ALL RESISTOR VALUES ARE IN OHMS (K=1000).
 2. FOR MODEL 4821-01, DELETE T1 AND JUMPER E7 TO E6 AND E3 TO E4.
 3. EHR DRAWING NO. 8170, REV. A.

Figure 5-2. Model 4821 Amplifier Card, Schematic Diagram



NOTES:

UNLESS OTHERWISE SPECIFIED,

1. ALL RESISTOR VALUES ARE IN OHMS (K=1000).

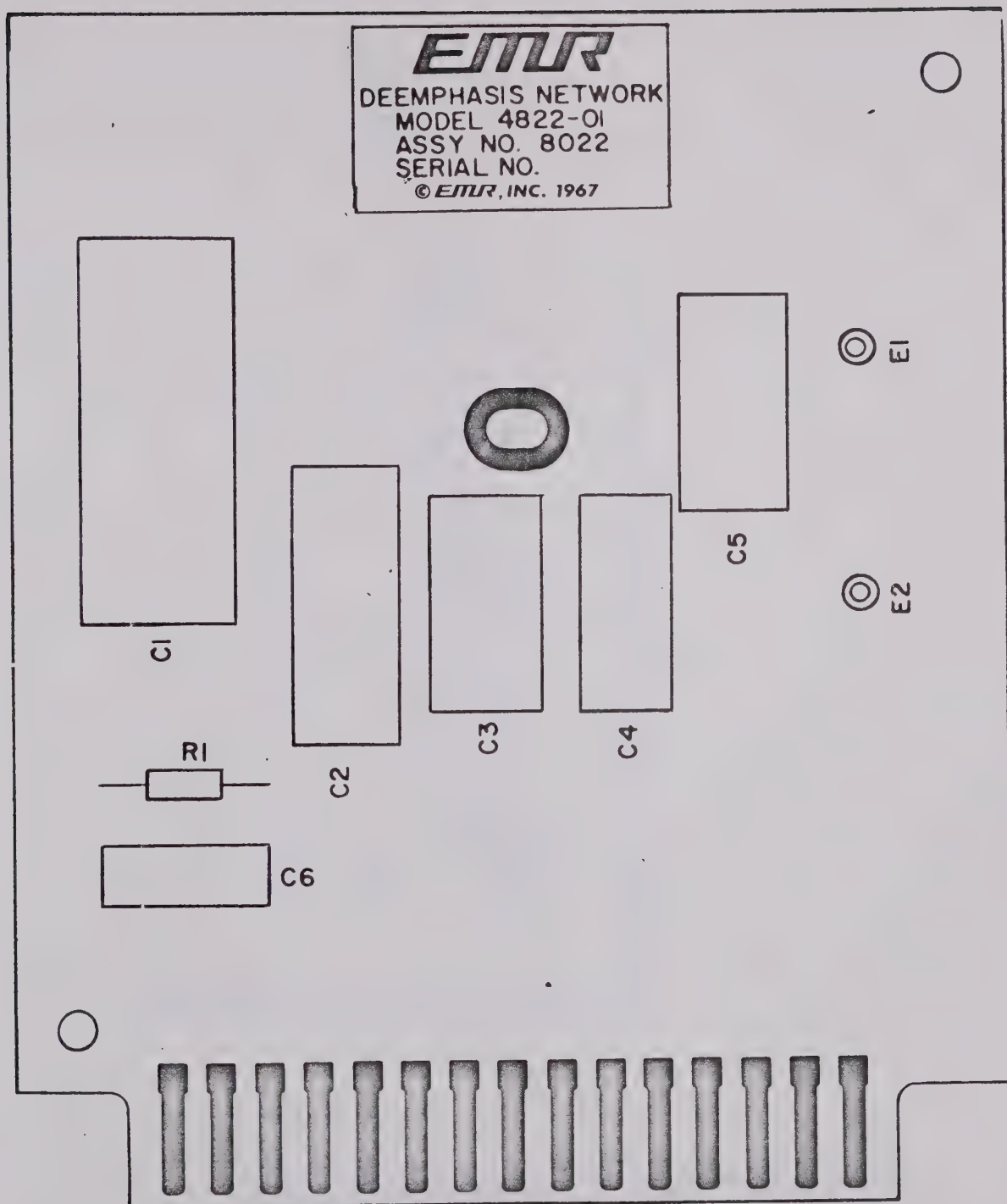
2. FOR DE-EMPHASIS; TYPE & VALUE TO BE DETERMINED BY CUSTOMER.

3. FOR MODEL 4821-01 DELETE T1 & JUMPER E7 TO E6 AND E3 TO E4.

4. VALUE TO BE 430 OHMS UNLESS OTHERWISE SPECIFIED ON DWG. 516B.

5. ENR DWG. NO. 8170 - REV C

Figure 5-2A. Model 4821 Amplifier Card, Schematic Diagram
(For unit serial nos. 52 and up)



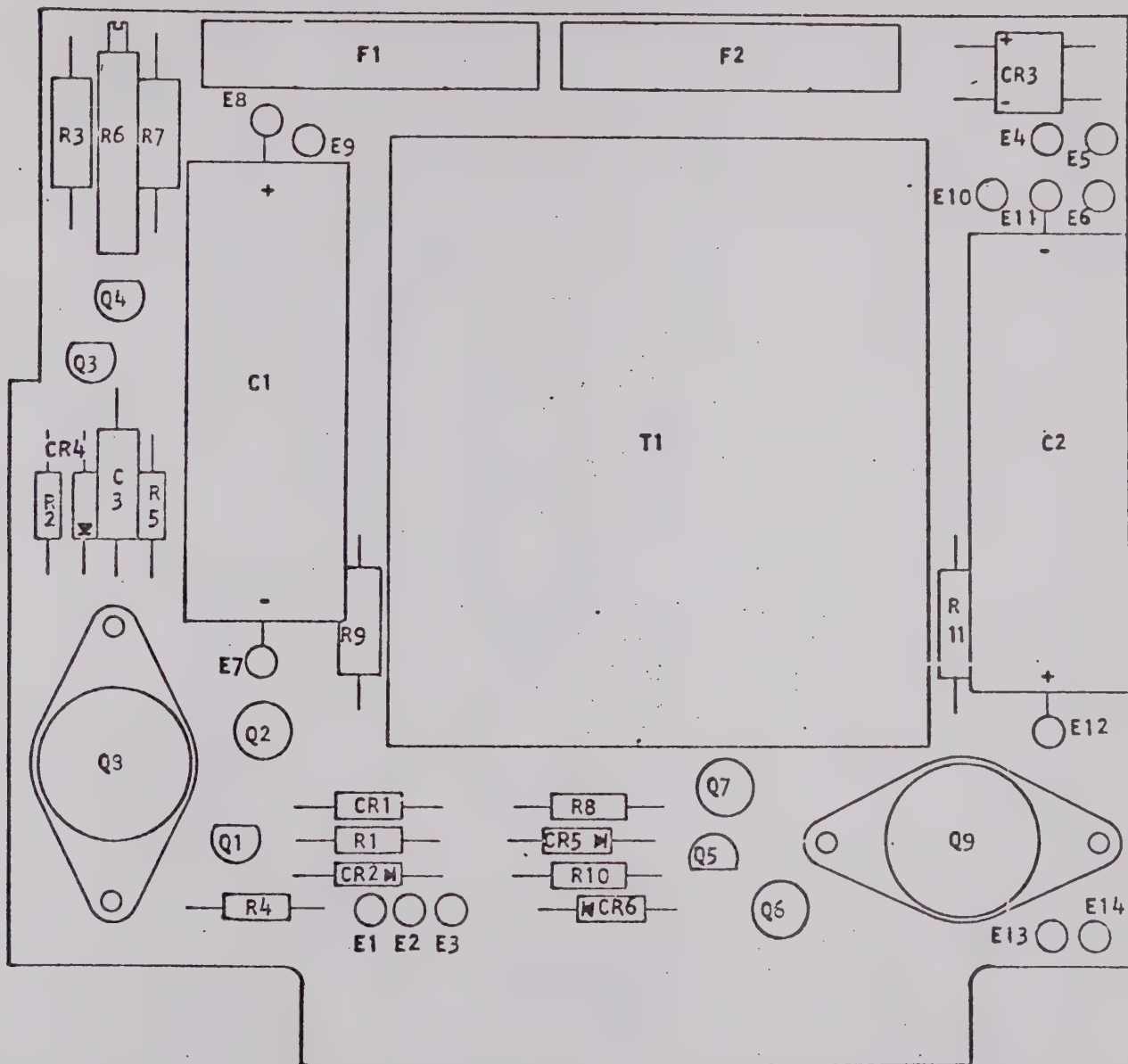
NOTE: EMR DWG. NO. 8022

Figure 5-3. Model 4822 Deemphasis Card,
Component Location Diagram



2. EMR DWG. NO. 8023

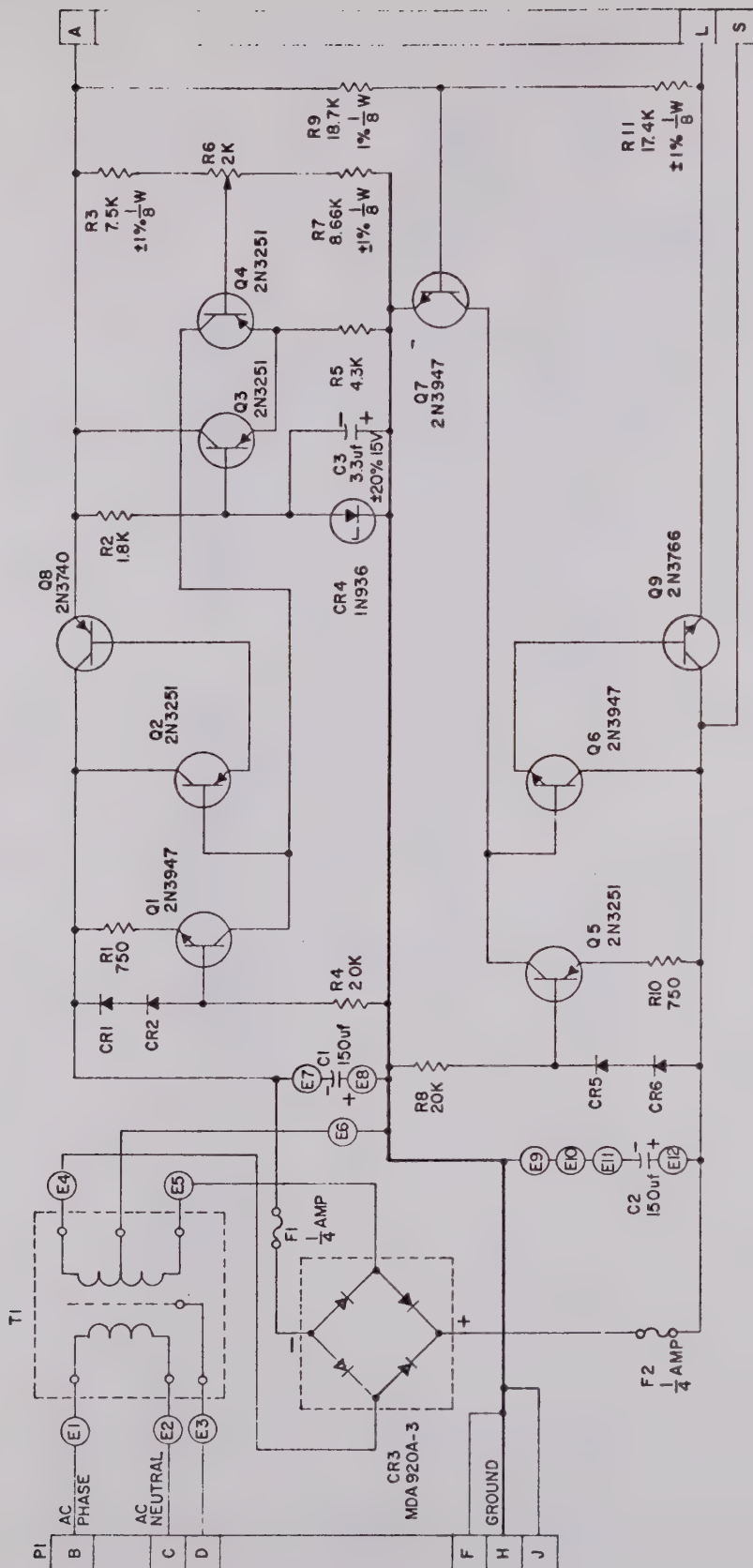
5-7



NOTE:

1. EHR DRAWING CONTROL NO. 4830-003.

Figure 5-5. Model 4525-01 and 4525-81 Power Supply Card,
Component Location Diagram

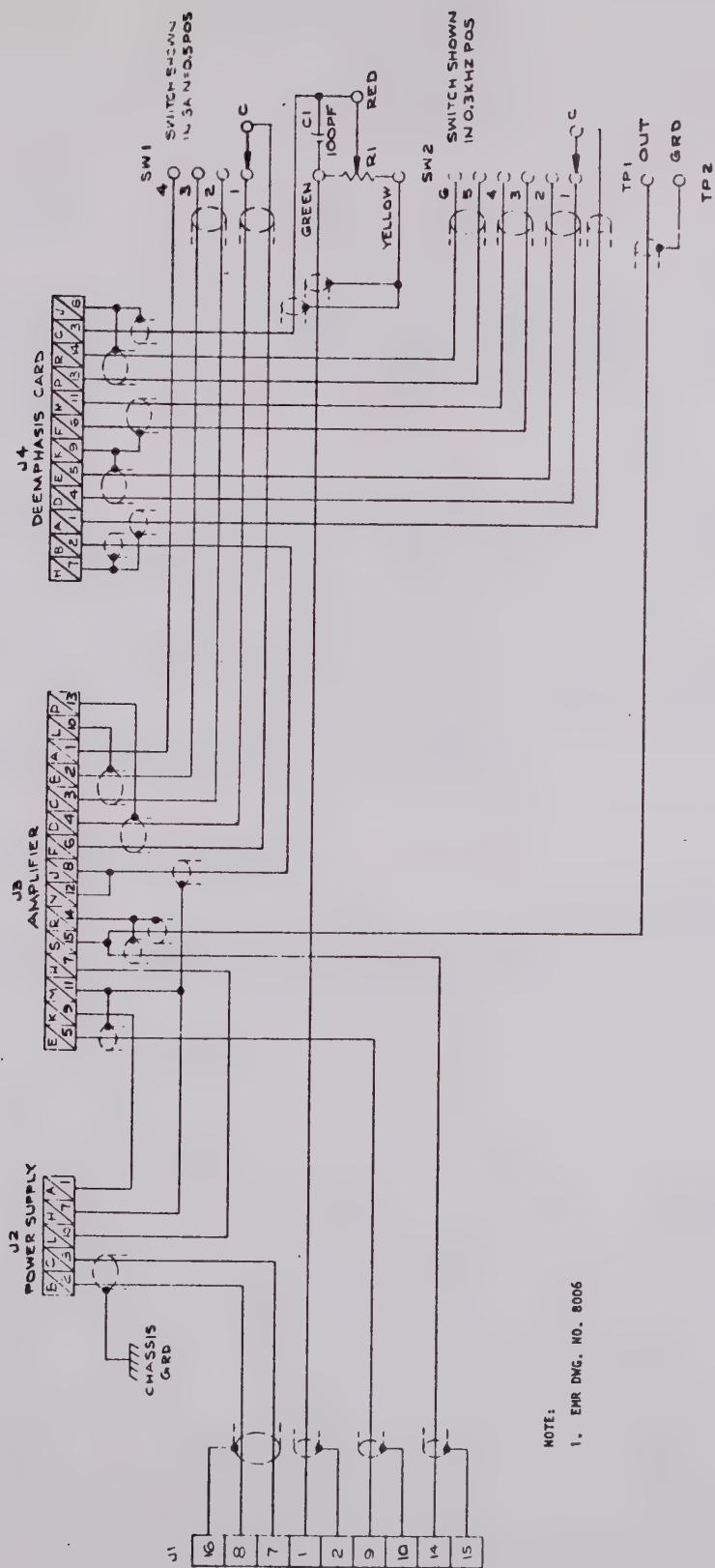


NOTES:

UNLESS OTHERWISE NOTED:

1. ALL RESISTOR VALUES ARE IN OHMS (K=1000) AND ARE $\pm 5\% \frac{1}{8}W$
2. ALL CAPACITORS ARE $\pm 150\% 50V$
3. ALL DIODES ARE PER EMR SPEC 663
4. EMR DWG. NO. 6050, REV. J

Figure 5-6. Model 4525-01 and 4525-81 Power Supply Card, Schematic Diagram



NOTE:
1. EHR DNG. NO. 8006

Figure 5-7. Model 4820 Wiring Diagram

SECTION 6

PARTS LISTS

6.1 GENERAL

This section contains the replaceable parts lists for the Model 4820 General-Purpose Amplifier. Parts information is presented in tabular form and is keyed to illustrations in other sections of this manual. Included in the parts lists is an overall assembly parts list, Table 6-1, and subassembly parts lists, Tables 6-2 and 6-3.

Information for each assembly, subassembly, or component includes an electrical reference designation (where applicable), a part description, an EMR stock number, the original manufacturer (MGFR CODE), and the manufacturer part number. Any item may be purchased from EMR using the identifying number in the EMR STOCK NO. column. However, the items may be obtained from the original manufacturer by using the part number contained in the MFGR. PART NO. column. To identify specific manufacturers, correlate the manufacturer code number (MFGR. CODE) with the manufacturers' names listed in Table 6-4.

6.2 ORDERING INSTRUCTIONS

When ordering parts, complete description of each part as listed in DESCRIPTION column of parts list must accompany order. Also included, must be the EMR stock number and manufacturer's name and part number.

Table 6-1. Model 4820 General-Purpose Amplifier Parts List (Ref. Figure 1-1)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
J1	MODEL 4820 GENERAL-PURPOSE AMPLIFIER	005-89-00003	06141	8002	1		
J2-J4	MODEL 4823 CHASSIS ASSEMBLY	042-89-00052	06141	8012	1		
	SUBCHASSIS ASSEMBLY	042-89-00051	06141	7996	1		
	REAR CONNECTOR	063-98-00042	13511	26-159-16	1		
	CARD CONNECTOR	063-98-00046	71785	250-15-30-171	3		
R1	POTENTIOMETER, 5K $\pm$ 5%, 1W	201-98-00081	06184	0252S-1-5K	1	1	
S1-S2	SWITCH, Rotary, 4-position	250-99-00014	06141	8009	2		
C1	CAPACITOR, 100 Pf $\pm$ 1%, 500V	304-20-10009	06141	600	1		
TP1-TP2	FRONT PANEL ASSEMBLY	191-89-00130	06141	8010-1	1		
	TEST JACK	143-98-00006	98291	SK1-8-white	2		
	MODEL 4822-01 DEEMPHASIS CARD	205-89-00033	06141	8022	1		
	(Ref. Figure 5-3)						
C1	CAPACITOR, 0.22 μ f $\pm$ 10%, 100V	361-01-22002	06141	809	1		
C2	CAPACITOR, 0.075 μ f $\pm$ 10%, 100V	361-01-75001	06141	809	1		
C3	CAPACITOR, 0.022 μ f $\pm$ 10%, 100V	361-01-22001	06141	809	1		
C4	CAPACITOR, 0.0075 μ f $\pm$ 10%, 100V	361-01-75000	06141	809	1		
C5	CAPACITOR, 2200 Pf $\pm$ 1%, 500V	305-20-22000	06141	600	1		
C6	CAPACITOR, 91 Pf $\pm$ 1%, 500V	304-20-09109	06141	600	1		
R1	RESISTOR, 5.1K $\pm$ 5%, 1/4W	616-02-51000	01121	RC07GF512J	1		
	MODEL 4821 AMPLIFIER CARD	205-89-00025	06141	8172	1		
	(See Table 6-2 for breakdown)						
	MODEL 4525-01 POWER SUPPLY CARD	205-95-00031	06141	6052	1		
	(See Table 6-3 for breakdown)						

Table 6-2. Model 4820 General Purpose Amplifier Parts List
(Ref. Figure 5-1)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	MODEL 4821-01 AMPLIFIER CARD (Used in Model 4820-01)	205-89-00025	06141	8172	1		Price and delivery of recommended spares on request.
	MODEL 4821-02 AMPLIFIER CARD (Used in Model 4820-02)	205-89-00026	06141	8172-1	1		
C1	CAPACITOR, 2 Pf ± 0.5 Pf, 500V	304-01-00209	06141	600	1		
C3	CAPACITOR, 6.8 μ f $\pm 20\%$, 35V	337-23-68003	06141	601	3	1	
C4	CAPACITOR, 2000 Pf $\pm 1\%$, 500V	305-20-20000	06141	600	1		
C5	CAPACITOR, 47 μ f $\pm 20\%$, 35V	339-23-47004	06141	601	2	1	
C6	CAPACITOR, 5 Pf $\pm .5$ Pf, 500V	304-01-00509	06141	600	1		
C7 & C8	CAPACITOR, 330 μ f $\pm 20\%$, 6V	339-19-33005	06141	601	2	1	
C9	(Same as C5)						
C10	(Same as C3)						
C11	CAPACITOR, 51 Pf $\pm 1\%$, 500V	304-13-05109	06141	600	1		
C12 & C13	CAPACITOR, 1 Pf ± 0.5 Pf, 500V	304-01-00109	06141	600	2		
C14	CAPACITOR, 430 Pf $\pm 1\%$, 500V	304-20-43009	06141	600	1		
C15	(Same as C3)						
CR1 & CR2	DIODE	088-99-00169	06141	663	2	1	
L1 & L2	COIL	055-89-00001	06141	956-1306	2		
Q1 & Q2	TRANSISTOR	263-10-35650	JEDEC	2N3565	2	1	
Q3	TRANSISTOR	263-10-39470	JEDEC	2N3947	1	1	
Q4	TRANSISTOR	263-10-36380	JEDEC	2N3638	1	1	
Q5	TRANSISTOR	263-10-29590	JEDEC	2N2959	1		
Q5*	TRANSISTOR, NPN, SW/AMP, 60V, TO5	263-16-29590	04713	2N2959	1	1	
Q6	TRANSISTOR	263-10-32510	JEDEC	2N3251	1	1	
Q7	TRANSISTOR	263-10-36410	JEDEC	2N3641	1	1	
Q8	TRANSISTOR	263-10-31340	JEDEC	2N3134	1		
Q8*	TRANSISTOR, PNP, SW/AMP, 50V, TO5	263-16-31340	04713	2N3134	1	1	
R1	RESISTOR, 5.1K $\pm 5\%$, 1/4W	616-02-51000	01121	RC07GF512J	3		
R2	RESISTOR, 1K $\pm 5\%$, 1/4W	616-02-10000	01121	RC07GF102J	1		
R3	RESISTOR, 430 Ohms $\pm 5\%$, 1/4W	616-02-43009	01121	RC07GF431J	3		
R4	RESISTOR, 27 Ohms $\pm 10\%$, 1/2W	622-03-02709	01121	RC07GF270K	2		
R5	RESISTOR, 10K $\pm 5\%$, 1/4W	616-02-10001	01121	RC07GF103J	1		
R6 & R7	(Same as R1)						

* Model 4820 Serial Nos. 50 and up.

Table 6-2 (Cont'd.). Model 4820 General-Purpose Amplifier Parts List
(Ref. Figure 6-1)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R8	RESISTOR, 2K $\pm 5\%$, 1/4W	616-02-20000	01121	RC07GF202J	1		Price and delivery of recommended spares on request.
R9	RESISTOR, 1.5K $\pm 5\%$, 1/4W	616-02-15000	01121	RC07GF152J	1		
R10	RESISTOR, 7.5K $\pm 5\%$, 1/4W	616-02-75000	01121	RC07GF753J	1		
R11	RESISTOR, 6.2K $\pm 5\%$, 1/4W	616-02-62000	01121	RC07GF622J	1		
R12	RESISTOR, 150 Ohms $\pm 5\%$, 1/4W	616-02-15009	01121	RC07GF151J	1		
R13 & R14	RESISTOR, 10 Ohms $\pm 5\%$, 1/4W	616-02-01009	01121	RC07GF100J	2		
R15	RESISTOR, 43 Ohms $\pm 5\%$, 1/2W	622-02-04309	01121	RC20GF430J	1		
R16	RESISTOR, 2.2K $\pm 5\%$, 1/4W	616-02-22000	01121	RC07GF222J	1		
R17	(Same as R3)						
R18	(Same as R4)						
R19	RESISTOR, 470 Ohms $\pm 5\%$, 1/4W	616-02-47009	01121	RC07GF471J	1		
R20	RESISTOR, 240 Ohms $\pm 5\%$, 1/4W	616-02-24009	01121	RC07GF241J	1		
R21	RESISTOR, 150 Ohms $\pm 5\%$, 1/4W	616-02-15009	01121	RC07GF151J	1		
R22	(Same as R3)						
T1	TRANSFORMER (Used on Model 4820-02 only)	999-01-00001	06141	8168	1		
C6*	CAPACITOR, 39 Pf $\pm .5$ Pf, 500V	304-08-03909	06141	600	1		
C11*	CAPACITOR, 110 Pf $\pm 1\%$, 500V	304-20-11009	06141	600	1		
R3*	RESISTOR, 100 Ohms $\pm 5\%$, 1/4W	616-02-10009	01121	RC07GF431J	1		
R8*	RESISTOR, 8.2K $\pm 5\%$, 1/4W	616-02-82000	01121	RC07GF202J	1		
R10*	RESISTOR, 16K $\pm 5\%$, 1/4W	616-02-16001	01121	RC07GF753J	1		
R16*	RESISTOR, 1K $\pm 5\%$, 1/4W	616-02-10000	01121	RC07GF222J	1		

* Model 4820 Serial Nos. 52 and up

Table 6-3. Models 4525-01 and 4820-01 Power Supply Card Parts List
(Ref. Figure 5-5)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	MODEL 4525-01 POWER SUPPLY CARD (used on Models 4820-01 and 4820-02)	205-89-00328	06141	6052 (Rev. B)	1		Price and delivery of recommended spares on request.
	MODEL 4525-81 POWER SUPPLY CARD (used on Model 4820-81)	205-89-00818	06141	6052-2	1		
C1 & C2	CAPACITOR, 150 Mf, -10%, +150%, 50V	365-06-15005	14655	BR150-50	2	1	
C3	CAPACITOR, 3.3 Mf, ±20%, 15V	336-21-33003	06141	601	1	1	
CR1 & CR2	DIODE	088-99-00169	06141	663	4		
CR3	DIODE	214-98-00003	04713	MDA920A-3	1	1	
CR4	DIODE	088-10-09360	JEDEC	1N936	1	1	
CR5 & CR6	(Same as CR1)						
F1 & F2	FUSE, Fast-Blo, 1/4 Amp	120-98-00030	75915	312.250	2	5	
Q1	TRANSISTOR	263-10-39470	JEDEC	2N3947	3	1	
Q2 thru Q5	TRANSISTOR (2N3251)	263-99-00139	06141	805-1	4	1	
Q6 & Q7	(Same as Q1)						
Q8	TRANSISTOR	263-10-37400	JEDEC	2N3740	1	1	
Q9	TRANSISTOR	263-10-37660	JEDEC	2N3766	1	1	
R1	RESISTOR, 750 Ohms ±5%, 1/4W	616-02-75009	01121	RC07GF751J	2		
R2	RESISTOR, 1.8K, ±5%, 1/4W	616-02-18000	01121	RC07GF182J	1		
R3	RESISTOR, 7.50K, ±1%, 1/8W	605-09-75000	06141	625	1		
R4	RESISTOR, 20K, ±5%, 1/4W	616-02-20001	01121	RC07GF203J	1		
R5	RESISTOR, 4.3K, ±5%, 1/4W	616-02-43000	01121	RC07GF432J	1		
R6	POTENTIOMETER, 2K, ±10%, 1W	201-98-00089	13511	2600P-202	1	1	
				QCR3016			
R7	RESISTOR, 8.6K ±1%, 1/8W	605-09-86600	06141	625	1		
R8	RESISTOR, 20K ±5%, 1/4W	616-02-20001	01121	RC07GF203J	1		
R9	RESISTOR, 18.7K ±1%, 1/8W	605-09-18701	06141	625	1		
R10	(Same as R1)						
R11	RESISTOR, 17.4K, ±1%, 1/8W	605-09-17401	06141	625	1		
T1*	TRANSFORMER, Power, 115V at 50-60 Hz	262-99-00052	06141	931	1		
T1**	TRANSFORMER, Power, 220V at 47-440 Hz	262-99-00101	06141	931-1	1		

*Used on Model 4525-01

**Used on Model 4525-81

TABLE 6-4. MANUFACTURERS' NAMES AND CODE NUMBERS

MFR'S CODE	MFR'S NAME AND ADDRESS
01121	Allen Bradley Co., Milwaukee, Wis.
03797	Eldema Corp., Compton, Calif.
04713	Motorola Semiconductor Products, Inc., Phoenix, Ariz.
05170	Engineered Electronics Co., Inc. Santa Ana, Calif.
06141	Electro-Mechanical Research, Inc., Sarasota, Florida
06184	Conelco Components, San Bernardino, Calif.
06540	Amathom Electronic Hardware Co., Inc., New Rochelle, N. Y.
07137	Transistor Electronics Corp., Minneapolis, Minn.
07263	Fairchild Camera and Instr. Corp. Semiconductor Div., Mountain View, Calif.
07716	IRC, Inc., Burlington, Iowa
09353	C and K Components, Inc., Newton, Mass.
09922	Burndy Corp., Norwalk, Conn.
12697	Clarostat Mfg. Co., Inc., Dover, N. H.
13511	Amphenol Corp., Los Gatos, Calif.
14655	Cornell-Dublier Electric Corp., Newark, N. J.
25244	Centralab Div. Globe-Union, Milwaukee, Wis.
56289	Sprague Electric Co., North Adams, Mass.
71450	CTS Corp., Elkhart, Ind.
71468	Cannon Electric Co., Los Angeles, Calif.
71744	Chicago Miniature Lamp Works, Chicago, Ill.
71785	Cinch Mfg. Co., Chicago, Ill.
74545	Harvey Hubbel, Inc., Bridgeport, Conn.

TABLE 6-4. MANUFACTURERS' NAMES AND CODE NUMBERS

MFR'S CODE	MFR'S NAME AND ADDRESS
74970	E. F. Johnson Co., Waseca, Minn.
75915	Littelfuse, Inc., Des Plaines, Ill.
78769	E. H. Titchener and Co., Binghamton, N. Y.
80294	Bourns, Inc., Riverside, Calif.
G81349	Military Specifications Promulgated by Standardization Div. Directorate of Logistic Services DSA
81590	Korrry Mfg. Co., Seattle, Wash.
83594	Burroughs Corp., Plainfield, N. J.
90201	Mallory Capacitor Co., Indianapolis, Ind.
91506	Augat, Inc., Attleboro, Mass.
91737	Gremar Mfg. Co., Inc., Wakefield, Mass.
93332	Sylvania Electric Prod., Inc. Semiconductor Prod. Div., Woburn, Mass.
94412	Dressen Barnes Electronic Corp., Pasadena, Calif.
95073	Douglas Randall, Inc., Westerly, R.I.
95275	Vitramon, Inc., Bridgeport, Conn.
95692	Artisan Electronics Corp., Parispany, N. J.
97564	Clare-Pendar, Inc., Post Falls, Idaho
98291	Sealelectro Corp., Mamaroneck, N. Y.

